STEEL FRAME RESPONSE TO PUENTE HILLS SCENARIO EARTHQUAKES
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ABSTRACT

- We simulate the response of real moment frames in several earthquakes on the Puente Hills fault beneath Los Angeles.
- The earthquakes include M6.7, 6.8, and 7.1 with long-period energy content; and M7.2 with broadband content.
- The building models are 12-story and represent six- and twenty-story buildings with one of two considered strengths and either brittle or ductile walls.
- We compare the results for:
  - several realizations of an earthquake of the fault (6a scenarios with the same magnitude but different slip distributions and/or hypocenter locations)
  - different magnitudes
  - six- and twenty-story buildings in the broadband ground motions

DESCRIPTION OF SIMULATIONS

- We employ two sets of ground motions:
  - Raw Graves generated ground motions with broadband energy content for a M7.13 earthquake on the Puente Hills fault. The five simulations have different slip distributions and the same hypocenter location.
  - SCGC generated long-period ground motions for M6.7, 6.8, and 7.1 events on one, two, or three segments of the fault. For each magnitude SCGC modeled three slip distributions and two hypocenter locations, giving six realizations.
- We use eight models of example tall, real, special moment-resisting frame (SMRF) buildings. Each model is characterized by the following:
  - higher-strength (design according to the 1992 Japanese Building Code) or lower-strength (design according to the 1994 Uniform Building Code), as measured by the base shear at yield
  - six- or twenty-stories
  - brittle or perfection (i.e., non-ducting) walls
- Abbreviate model as letter and number combination. For example, J6f is a model designed to the Japanese Building Code with six-stories and non-ducting walls.
- We measure building model response with peak inter-story drift ratio (PSIDR). FEMA 356 defines damage states to steel frame buildings in terms of PSIDR: PSIDR > 0.007 allows "immediate occupancy", PSIDR > 0.025 denotes "life safety", PSIDR > 0.05 indicates "structural collapse." We deem a model that reaches PSIDR > 0.2 as a "simulated collapse" since real buildings cannot remain stable or at large drifts.

PUSHOVER CURVES

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MULTIPLE REALIZATIONS

- The figures above and below show the USGP model response to multiple realizations of two scenario earthquakes. The results show variability in the building responses, in terms of both the geographic pattern and the extent of six responses. In general, there are extremely large model responses in the area of peak and soft soil of the Puente Hills fault. At specific sites, however, the building responses vary. These figures demonstrate the conclusion based on a single scenario earthquake model that the variability one would see in multiple realizations on one scenario provides a rough estimate of possible building damage, but specific scenarios should be run to account for the uncertainty of modeling plausible earthquakes.

SIX- VS. TWENTY-STORIES

- The above two observations are likely explained by the P-Delta effect. Under large lateral deformations, the columns are no longer approximated vertical. This in turn adds an additional moment to the columns, since vertical loads "P" are carried a distance "A" from the vertical axis. Since the large drifts are concentrated in the lower stories of models at both heights, the moment due to "P-A" are much larger in the twenty-story buildings.

DIFFERENT MAGNITUDES

CONCLUSIONS

- At specific sites there can be variability in the building response due to multiple realizations of a scenario earthquake. Conclusions based on a single scenario should consider this variability.
- More twenty-story buildings show simulated collapse than six-stories. If the buildings do not collapse, then more six-story buildings experience peak inter-story drifts that exceed "life safety" as defined by FEMA 356 than do twenty-story buildings.